UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/065,037	09/12/2002	Timothy J. Havens	GEMS0139PUS	9590

27256 7590 04/06/2004

ARTZ & ARTZ, P.C.
28333 TELEGRAPH RD.
SUITE 250
SOUTHFIELD, MI 48034

EXAMINER	
FETZNER, TIFFANY A	

ART UNIT	PAPER NUMBER
2859	

DATE MAILED: 04/06/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

μ/

Office Action Summary	Application No.	Applicant(s)
	10/065,037	HAVENS ET AL.
	Examiner	**Art Unit**
	Tiffany A Fetzner	2859

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 23 January 2004.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-20 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-20 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on 12 September 2002 is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED 2nd Non-Final ACTION

1. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Drawings

2. The drawings are still objected to as failing to comply with 37 CFR 1.84(p)(5) because contrary to applicant's statement on page 2 paragraph 2 of the January 9th 2004 response. The response does not include an attached drawing correction to Figure 1 for examiner approval. Only a seven page response was received by the USPTO. Therefore the drawings are still objected to as failing to comply with 37 CFR 1.84(p)(5) because the following reference sign(s) mentioned in the description, are not shown.

A) In Figure 1 the **super conducting magnetic field coils 16**, taught on page 5 paragraph [0022] are not shown.

B) In Figure 1 the **second exterior side 54** and the **cylindrical dielectric former 56**, taught on page 6 paragraph [0026] are not shown. A proposed drawing correction or

corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

Response to Arguments

3. Applicant's arguments with respect to **claims 1-20** have been considered but are moot in view of the new ground(s) of rejection.

4. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

5. **Claims 1-20** are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention, because applicant argues in the January 9th 2004 response that a functional device which performs applicant's method, via appropriate components is different than applicant's "inventive simulator". In review of applicant's claims, based upon applicant's submitted arguments. The scope of applicant's claims is vague because applicant fails to define in the specification the components which constitute the "rigid body motion generator", the specific "magnetic stiffness and damping signal" generated by the eddy current analyzer; the mechanical model generator, the structural analyzer, and the field instability calculator.

6. The issues of concern are raised because while applicant's figure 1 shows an actual MRI device, and Figure 3 shows the method steps. Figure 2 is ambiguous. The examiner cannot ascertain from applicant's specification, or figures if the components listed in box 80 are actual separate components, or simply a series of method steps. The examiner interpreted figure 2 to be actual components similar to figure 1 in the first

office action, and applicant's argues in the January 9th 2004 response that the **applicant's inventive simulator is not an actual MRI system.**

7. Without applicant clarifying specifically what components comprise component numbers 82, 86, 88, 90, and the overall component 80. The determination of what constitutes valid prior art against the claims of this application is unresolved. If each of these Figure 2 components are implemented as part of an overall computer system. Applicant should clarify that fact. Additionally, if component numbers 82, 86, 88, 90, and the overall component 80 each correspond to the same physical computer component in actuality applicant needs to state that these components are separate method steps as opposed to being separate components.

8. This 112 rejection is based on issues raised because of applicant's January 9th 2004 response. The examiner notes that the claims fail to require "simulated" components in each of the limitations of the independent claims. However, in view of applicant's arguments that applicant's invention is **to an MRI simulator, and not an actual MRI device**, (i.e. such as **Kinanen** US patent **6,433,550 B1** issued August 13th 2002, filed February 13th 2001; which accomplishes all of the features of applicant's claims using an actual system) a new prior art search for an MRI device using simulated data for all steps was conducted. The new art of **Kanayama et al.,** US patent 5,519,320 issued May 21st 1996, is relevant given applicant's arguments.

9. The examiner is not persuaded that **Kinanen** is not prior art because of the 112 issues raised as a result of applicant's arguments. Therefore **Kinanen** is still considered to be valid prior art against the applicant's claims. However, the examiner

acknowledges that **Kinanen** is not a MRI simulator only. Therefore, the original rejections based on **Kinanen** follow the rejections based upon the new **Kanayama et al.,** reference, because applicant's claims fail to clarify that applicant's invention is for an MRI simulator only.

10. NOTE: all of the claim rejections listed hereafter are relevant to the application, as best as the examiner can ascertain from the currently pending claims the prior art is relevant. The claims were searched even with the aforementioned 35 USC 112 objections as raised above, with consideration given to applicant's January 9th 2004 arguments to ensure that this examination was as thorough as possible.

Claim Rejections - 35 USC § 103

11. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

12. The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

13. **Claims 1-17,** and **19** are rejected under **35 U.S.C. 103(a)** as being unpatentable over **Kanayama et al.,** US patent 5,519,320 issued May 21st 1996.

14. With respect to apparatus **claim 1,** and corresponding method **claim 9**, **Kanayama et al.,** teaches and suggests "A Magnetic Resonance Imaging (MRI) magnet field instability simulator" [See Figure 11, component 24, abstract, col. 4 lines 1-7; col. 6 lines 31-42, col. 12 lines 21-22; .] **Kanayama et al.,** also teaches and suggests components "comprising: a rigid body motion generator simulating motions of one or more MRI system components"; [See sequence controller component 9, which is responsible for carrying out the simulation of each of the MRI system components; col. 6 lines 32-42; col.. 9 line 57 through col. 10 line 68]. **Kanayama et al.,** teaches and shows the presence of "an eddy current analyzer" [See Figure 6, component 48] "generating" an eddy current compensation signal a magnetic stiffness and damping signal", [See figure 6 col. 9 lines 1-10]

15. **Kanayama et al.,** lacks directly teaching that an eddy current compensation signal is a "magnetic stiffness and damping signal". However, an eddy current compensation signal **is** a type of "magnetic stiffness and damping signal", because a uniform, static, constant, or homogeneous magnetic field which does not change is a "magnetically stiff" magnetic field, and the eddy current compensation signal, **is** a measurement of magnetic inhomogeneity, or the variation from the desired "magnetically stiff" homogeneous magnetic field, which is determined and then applied in a manner to "dampen" (i.e, cancel out / nullify) the inhomogeneous eddy currents by altering the gradient magnetic fields applied to ensure that "magnetic stiffness" (i.e. magnetic uniformity) is optimal at the center of the imaging volume. [See Figure 6; col. 9 lines 1-10]. Additionally, because an eddy current compensation signal is provided to:

gradient field amplifier 41, and the gradient coil(s) component(s) identified as component number 3, [See figure 6] it would have been obvious to one of ordinary skill in the art at the time that the invention was made that the eddy current analyzer generates a "magnetic stiffness and damping signal". Additionally, **Kanayama et al.,** teaches and shows "an electromagnetic transfer function in response to said motions" (i.e. the electromagnetic transient response shown in figure 7b).

16. The **Kanayama et al.,** reference lacks directly teaching that the eddy current analyzer generates "a cryostat material properties signal". However, the **Kanayama et al.,** reference teaches simulating the "nuclear spin density distribution" [See col. 4 lines 1-7] and a simulated nuclear spin density is a type of cryostat material properties signal because in NMR / MRI the purpose of the superconductive main magnet cryostat is to generate a strong, uniform / static / homogeneous "nuclear spin density" magnetic field, which is strong enough (i.e. about 0.5 Tesla or higher) to image a large region or volume of a subject / patient.

17. The examiner notes that **Kanayama et al.,** teaches and shows a main magnet (i.e. component number 1 in figure 1), powered by a main magnet power source component 2, (i.e. interpreted broadly by the examiner as a cryostat) also shown in figure 1. [See col. 5 lines 33-37]. The examiner is interpreting the "main magnet power source" to broadly represent a conventional MRI / NMR superconductive cryostat because Figure 1 shows an NMR / MRI apparatus main magnet used to image the body of a patient 5, and conventionally in the NMR / MRI art, magnets which image the body of a patient or a large volume / region of interest are, unless otherwise specified by the

reference, superconductive, due to the fact that a large homogeneous imaging volume is needed. Superconductive main magnets (i.e. the examiner is interpreting component 1 in figure 1 to represent a superconductive main magnet) intrinsically include a cryostat, because the cryostat keeps the main magnet operating at superconductive temperatures, which increases the strength and homogeneous volume of the generated main magnetic field. Without the required cryostat the main magnet would not be maintainably superconductive, and the effective imaging volume would be smaller than diagnostically usable, for large volume patient body imaging, without special system modifications.

18. Because the **Kanayama et al.,** reference fails to teach if the main magnet is of a permanent, resistive, or superconductive type, all types are considered to be within the scope of the **Kanayama et al.,** reference. Additionally, because the **Kanayama et al.,** reference shows a main magnet power source, for the main magnet, (i.e. a requirement in all superconductive MRI / NMR systems), it would have been obvious to one of ordinary skill in the art at the time that the invention was made, that the examiner's interpretation of the main magnet being a superconductive magnet, and the main magnet power source 2 as a cryostat, is supported by figures 1, 6, and col. 5 line 28 through col. 6 line 48.]

19. Figure 1 of **Kanayama et al.,** also shows that main magnet power source 2 is coupled to system controller 9, [See figure 1] with system controller 9 coupled to the eddy current compensation analyzer unit 48 as shown in figure 6. Therefore, it would have been obvious to one of ordinary skill in the art at the time that the invention was

made that the eddy current analyzer (i.e. component 48) receives a signal from the main magnet power source (i.e. interpreted broadly as a cryostat, by the examiner) and that the eddy current compensation signal (i.e. the magnetic stiffness and damping signal) of **Kanayama et al.,** is generated at least in response to a signal from "main magnet power source 2" (i.e. the intrinsic cryostat of **Kanayama et al.,**) which broadly represents "a cryostat material properties signal", within the **Kanayama et al.,** reference even though the exact "cryostat material properties signal" terminology is lacked by **Kanayama et al.**

20. The **Kanayama et al.,**) reference also teaches and suggests from figure 1, "a mechanical model generator" (i.e. simulator component 24, shown in figure 11) which is capable of "generating a mechanical disturbance signal and a mechanical model of one or more MRI system components in response to said motions and said magnetic stiffness and damping signal;" [See abstract, col. 4 lines 1-7; col. 4 lines 27-35; col. 6 lines 31-42; col. 9 line 57 through col. 11 line 24] The **Kanayama et al.,**) reference also teaches "a structural analyzer" (i.e. Host computer 12 in figure 1, and CPU 21 in figure 11) for "generating a motion signal in response to said mechanical model; and "a field instability calculator" (i.e. gradient power source component 4, which includes the eddy current compensation unit 48) for "generating a field instability signal in response to said electromagnetic transfer function and said motion signal". [See col. 9 line 1 through col. 10 line 68].

21. With respect to **claim 2, Kanayama et al.,** teaches and suggests "at least one of an internal mechanical disturbance signal" (i.e. a fluctuation of the strength of the main

field, such as the amount of change, variations in the output voltage waveform, or physical shifts of the radio frequency or gradient coils. [See col. 8 lines 7-43]) "and an external mechanical disturbance signal" (i.e. patient weight, presence and motion) [See col. 9 lines 26-30; Figure 10) The same reasons for rejection, and obviousness, that apply to **claim 1** also apply to **claim 2**.

22. With respect to **claim 3**, **Kanayama et al.,** teaches "said mechanical disturbance signal comprises information corresponding to at least one of cryostat motion, coil motion, magnet motion, and environmental motion." [See col. 8 lines 7-43, col. 9 lines 26-30; col. 1 line 34 through col. 2 line 9; col. 4 lines 23-35; Figures 10, 11, 3A, 3b abstract] The same reasons for rejection, and obviousness, that apply to **claims 1, 2** also apply to **claim 3**.

23. With respect to **claim 4**, **Kanayama et al.,** teaches "said motion signal comprises information corresponding to at least one of cryostat motion, coil motion, magnet motion, and environmental motion." [See col. 1 lines 34-50; col. 6 lines 31-42; col. 8 line 25 through col. 10 line 68] The same reasons for rejection, and obviousness, that apply to **claim 1** also apply to **claim 4**.

24. With respect to **claim 5**, **Kanayama et al.,** teaches "said mechanical model comprises at least one of magnet geometry" (i.e. system configuration) "material properties boundary conditions, and magnet stiffness and damping (i.e. eddy current compensation)." [See col. 8 line 25 through col. 10 line 68; Figures 2, 10] The same reasons for rejection, and obviousness, that apply to **claim 1**also apply to **claim 5**.

25. With respect to **claim 6**, and **corresponding method claim 12**, **Kanayama et al.,** teaches and suggests that the "structural analyzer" (i.e. Host computer 12 in figure 1, and CPU 21 in figure 11 in combination with sequence controller 9) "converts nodal displacements" (i.e. fluctuations in the magnetic field strength) "into rigid body motions" simulating motions of one or more MRI system components. [See col. 11 lines 20-41, col. 9 line 57 through col. 10 line 68.] The same reasons for rejection, and obviousness, that apply to **claims 1, 9, 11,** also apply to **claims 6, 12**.

26. With respect to **claim 7**, and **corresponding method claim 13**, **Kanayama et al.,** directly suggests that the "field instability calculator" (i.e. gradient power source component 4, which includes the eddy current compensation unit 48 "multiplies" (i.e. modulates or scales) "said rigid body motions by said electromagnetic transfer function to produce said field instability signal", [See Equation 3; col. 9 lines 1 through col. 10 line 68, col. 11 lines 20-68] The same reasons for rejection, and obviousness, that apply to **claims 1, 6, 9** also apply to **claims 7, 13**.

27. With respect to **claim 8**, and **corresponding method claim 14**, **Kanayama et al.,** suggests that the "field instability signal comprises a frequency distribution of field disturbances" [See col. 8 lines 25-43; especially col. 8 line 32; figure 5 resonant frequency f_0, figure 13Bthe frequency offsets] The same reasons for rejection, and obviousness, that apply to **claims 1, 9,** also apply to **claims 8, 14**.

28. With respect to **claim 10, Kanayama et al.,** teaches that the step of "generating an electromagnetic transfer function comprises performing an eddy current analysis"

[See col. 9 line 1 through col. 11 line 68] The same reasons for rejection, and obviousness, that apply to **claims 1, 9** also apply to **claim 10**.

29. With respect to **claim 11, Kanayama et al.,** teaches and suggests the step of "performing a structural analysis of one or more MRI system components", because **Kanayama et al.,** teaches designing pulse sequences based on simulated RF pulses, simulated magnetic gradients, simulated static magnetic fields, and simulated spin density distributions, where the simulations are based on an "analysis of one or more MRI system components". [See col. 4 lines 23-36]. The same reasons for rejection, and obviousness, that apply to **claims 1, 9** also apply to **claim 11**.

30. With respect to **claim 15, Kanayama et al.,** teaches and suggests "modifying at least one MRI system feature to adjust one or more resulting frequency magnitudes" [See col. 8 lines 25-43; col. 9 line 57 through col. 11 line 68] The same reasons for rejection, and obviousness, that apply to **claims 1, 9** also apply to **claim 15**. .

31. With respect to **claim 16, Kanayama et al.,** teaches and suggests "modifying at least one MRI system feature to adjust a resulting frequency operating band to be approximately within a desired frequency operating range." [See col. 8 lines 25-43; col. 9 line 57 through col. 11 line 68] The same reasons for rejection, and obviousness, that apply to **claims 1, 9** also apply to **claim 16**.

32. With respect to **claim 17, Kanayama et al.,** suggests balancing a resulting eddy current with a resulting amount of MRI system component movement in response to said field instability signal", [See col. 9 line 1 through col. 11 line 68; Figure 6] The same reasons for rejection, and obviousness, that apply to **claims 1, 9** also apply to **claim 17**.

33. With respect to **claim 19** this claim is just the combination of **method claims 9, 14,** and **16** written in independent form therefore the same reasons for rejection, and obviousness, that apply to **claims 1, 9, 14, 16** also apply to **claim 19** and need not be reiterated.

34. **Claims 18, 20** are rejected under **35 U.S.C. 103(a)** as being unpatentable over **Kanayama et al.,** US patent 5,519,320 issued May 21st 1996; as applied to **claims 1-17, 19** above in further view of **Yamashita** US patent **6,556,012 B2** filed January 19th 2001.

35. With respect to **claim 18, Kanayama et al.,** lacks directly teaching the step of "modifying a cryostat or cryostat support material in response to said field instability signal". However, **Yamashita** teaches and shows a superconductive MRI cryostat for maintaining the extremely low temperature state of the superconductive coil. [See col. 4 lines 37-45] **Yamashita** also teaches compensating for any vibrations of the system. [See col. 4 line 36 through col. 32 line 45, which explains 15 different embodiments for compensating for the vibrations produced by the MRI system]. The instability signal of **Yamashita** is also the signal(s) related to the vibrations experienced by the different components of the MRI system. **Yamashita** teaches "modifying a cryostat or cryostat support material in response to" the vibrations produced by the system (i.e. "said field instability signal"), [See col. 5 line 2 through col. 6 line 46; col. 22 line 17 through col. 23 line 55; col. 20 lines 5-49]. It would have been obvious to one of ordinary skill in the art at the time that the invention was made to modify the teaching of **Kanayama et al.,** which simulates magnetic field instabilities with the teaching of **Yamashita,** because the

teachings of **Kanayama et al.,** apply to any MRI magnet system, including a superconductive system, as explained in the rejection of **claim 1**, and the teachings of **Yamashita,** apply specifically to superconductive MRI systems and **Kanayama et al.,** component 2 of figure 1. The examiner also notes that because the cryostat is a rigid body that is also subject to motion during the course of an MRI / NMR imaging scan, it also would have been obvious to one of ordinary skill in the art at the time that the invention was made, to modify the MRI pulse sequencer teachings of **Kanayama et al.,** to simulate and analyze the vibrations generated within a functional superconductive MRI cryostat, because the **Kanayama et al.,** reference monitors, analyzes, simulates and compensates for all MRI components that effect or are affected by the operational components that comprise an MRI / NMR system, and an MRI cryostat falls within the scope of the **Kanayama et al.,** reference, for the same reasons given in the rejection of **claim 1**. The same reasons for rejection, and obviousness, that apply to **claims 1, 9** also apply to **claim 18**.

36. With respect to **claim 20**, **Kanayama et al.,** suggests "balancing a resulting eddy current with a resulting amount of MRI system component movement in response to said field instability signal" for the same reasons as those given in the rejection of **claim 17.**

37. **Kanayama et al.,** lacks directly teaching the step of using that balance "to determine desired cryostat materials; and modifying a cryostat or cryostat support material to reflect said desired cryostat materials." However, **Yamashita,** specifically determines and identifies "desired cryostat materials;"), [See col. 5 line 2 through col. 6

line 46; col. 22 line 17 through col. 23 line 55; col. 20 lines 5-49; Figures 1-6; 17-20; 24a-24d; 27-33 and 50-51]. **Yamashita,** also teaches "modifying a cryostat or cryostat support material to reflect said desired cryostat materials." [See col. 5 line 2 through col. 6 line 46; col. 22 line 17 through col. 23 line 55; col. 20 lines 5-49] The same reasons for rejection, and obviousness, that apply to **claims 1, 9, 14, 16, 17, 18, 19** and the motivation to combine that applies to **claim 18,** also apply to **claim 20** and need not be reiterated.

38. **Original rejections** which still apply until applicant's claims clarify that the invention of the instant application is an MRI simulator, and not an actual operation MRI system, (i.e. until the claims match applicant's January 9th 2004 arguments).

39. **Claims 1-17,** and **19** are rejected under **35 U.S.C. 103(a)** as being unpatentable over **Kinanen** US patent **6,433,550 B1** issued August 13h 2002, filed February 13th 2001.

40. With respect to apparatus **claim 1,** and corresponding method **claim 9**, **Kinanen** teaches and suggests "A Magnetic Resonance Imaging (MRI) magnet field instability simulator" (i.e. interpreted as an MRI device, capable or analyzing, and producing corrections for instabilities (i.e. fluctuations, or inhomogeneities) in the magnetic fields produced by the MRI device.) [See Figure 1, force transducer 60, vibration analyzer 62, reconstruction processor 52, local oscillator / synthesizer 80; the abstract; col. 2 line 36 through col. 5 line 60.] **Kinanen** also teaches and suggests components "comprising: a rigid body motion generator" (i.e. force transducer 60 which senses vibrations, disturbances, or rigid body motions of the MRI systems components such as

compression or expansion of the magnetic pole pieces in the lateral, vertical, horizontal, or diagonal directions.) [See col. 4 line 21 through col. 5 line 60; abstract; col. 2 lines 36-63]. The examiner notes that the "force transducer 60, vibration analyzer 62, reconstruction processor 52, and local oscillator / synthesizer 80" in combination with one another "simulate", account for (i.e. measure or determine), and compensate for, "motions of one or more MRI system components"; [See Figure 1; the abstract; col. 2 line 36 through col. 5 line 60.]

41. **Kinanen** lacks directly teaching the presence of "an eddy current analyzer" specifically, however, **Kinanen** teaches that RF screens are used to minimize RF eddy currents produced by the gradient coils 24, 26. [See col. 3 lines 60-65] The examiner notes that a shim coil is a type of RF screen, and conventionally shim coils are used to minimize eddy currents, therefore It would have been obvious to one of ordinary skill in the art at the time that the invention was made that shim coils 70 and 72 controlled by shim control 74 for the purpose of counteracting the changes in the magnetic field, is effectively a type of "eddy current analyzer", even though the specific term "eddy current analyzer", is not directly taught by the **Kinanen** reference.

42. The **Kinanen** reference suggests "generating a magnetic stiffness and damping signal" [See col. 4 lines 21-52 where high frequency vibrations are dampened and the hardness and compressibility of the magnetic pole shoes (i.e. the stiffness of the magnet structure itself) is taught to be compensated, by an output voltage. The output voltage is interpreted by the examiner as "an electromagnetic transfer function in response to said motions" (i.e. in response to the sensed vibrational motion of the

device). The **Kinanen** reference also suggests "a cryostat material properties signal" , because the amount of vibration, the magnetic field strength, the changes in the resonance frequency, or the shift in sensitivity during the operation of the MRI device are all signals, which are directly related to cyrostatic material properties. Additionally, it would have been obvious to one of ordinary skill in the art at the time that the invention was made that because the **Kinanen** reference does not specify the type or open MR system analyzed, by the vibrational method, (i.e. the **Kinanen** reference lacks a teachings which specifies a permanent, resistive, or superconductive (i.e. cyrostatic) main magnet structure), that all of the conventional permanent, resistive, and / or superconductive (i.e. cyrostatic) MR systems are within the broad scope of the **Kinanen** reference, and that all of the main MR magnets used in conventional MRI devices can be modified to include **Kinanen's** vibrational analyzer, force transducers, and frequency oscillator's / synthesizer's as taught by **Kinanen.** Therefore, the examiner considers the vibrational signals, related to the main magnets, the field strength of the main magnets, the main magnet frequency shifts, and the sensitivity shift of the main magnets to comprise "a cryostat material properties signal".

43. The **Kinanen** reference also teaches and suggests from figure 1, "a mechanical model generator" (i.e. the force transducer, and its generated output waveform are a type of "mechanical model generator" which is capable of "generating a mechanical disturbance signal and a mechanical model of one or more MRI system components in response to said motions and said magnetic stiffness and damping signal;" [See abstract, col. 2 line 6 through col. 3 line 5; col. 4 line 21 through col. 5 line 60]. The

Kinanen reference also teaches "a structural analyzer" (i.e. vibrational analyzer 62) for "generating a motion signal in response to said mechanical model; and "a field instability calculator" (i.e. the vibration analyzing processor of col. 2 lines 62-63] for "generating a field instability signal in response to said electromagnetic transfer function and said motion signal". [See col. 4 line 21 through col. 5 line 60; col. 2 lines 36-63].

44. With respect to **claim 2**, **Kinanen** teaches and suggests **"**at least one of an internal mechanical disturbance signal" (i.e. a fluctuation of the strength of the main field, such as the amount of change, variations in the output voltage waveform, or physical shifts of the radio frequency or gradient coils. [See col. 1 lines 42-62 col. 4 lines 48-52;]) "and an external mechanical disturbance signal" vibrations caused by (i.e. people walking in the examination room, slamming doors, trucks in the street, seismic activity, acoustic reverberations, and RF activity) [See col. 1 line 67 through col. 2 line 5;]. The same reasons for rejection, and obviousness, that apply to **claim 1** also apply to **claim 2**.

45. With respect to **claim 3**, **Kinanen** teaches "said mechanical disturbance signal comprises information corresponding to at least one of cryostat motion, coil motion, magnet motion, and environmental motion." [See abstract, col. 1 line 67 through col. 5 line 60] The same reasons for rejection, and obviousness, that apply to **claims 1, 2** also apply to **claim 3**.

46. With respect to **claim 4**, **Kinanen** teaches "said motion signal comprises information corresponding to at least one of cryostat motion, coil motion, magnet motion, and environmental motion." [See abstract, col. 1 line 67 through col. 5 line 60]

The same reasons for rejection, and obviousness, that apply to **claim 1** also apply to **claim 4**.

47. With respect to **claim 5**, **Kinanen** teaches "said mechanical model comprises at least one of magnet geometry material properties, boundary conditions, and magnet stiffness and damping." [See abstract, figure 1, col. 1 line 14 through col. 5 line 60] The same reasons for rejection, and obviousness, that apply to **claim 1** also apply to **claim 5**.

48. With respect to **claim 6**, **Kinanen** suggests that the "structural analyzer" (i.e. vibrational analyzer 62) "converts nodal displacements" (i.e. fluctuations in the distance between the magnetic poles, and magnetic field strength, with an example provided being a displacement of 1 ppm) "into rigid body motions". (i.e. how much the static structures including the magnets, poles, and coils, move. [See col. 1 lines 55-62; col. 2 line 35-63; col. 4 line 21 through col. 5 line 60.] The same reasons for rejection, and obviousness, that apply to **claim 1**also apply to **claim 6**.

49. With respect to **claim 7**, **Kinanen** suggests that the "field instability calculator" (i.e. the vibration analyzing processor of col. 2 lines 62-63] "multiplies" (i.e. scales) "said rigid body motions by said electromagnetic transfer function to produce said field instability signal", because **Kinanen** teaches that the analyzing processor affects the operating frequency of the main oscillator to counteract the vibrations. [See col. 2 lines 40-42; and col. 4 line 61 through col. 5 line 4 where the change in distance is converted into a change in magnetic field Bo, with shim coils counteracting changes in Bo and the waveform inverted and scaled in comparison to the vibration waveform.] The output

waveforms are interpreted by the examiner as an "electromagnetic transfer function" and in the **Kinanen** reference the "rigid body motions" (i.e. vibrations) of the actual system components, is related to the output waveform, and the vibrational waveform, via scaling and inversion to determine and correct the magnetic field instabilities, (i.e. to determine and counteract any fluctuations in the magnetic field. [See col. 4 line 21 through col. 5 line 60; abstract; col. 2 lines 36-63.] The same reasons for rejection, and obviousness, that apply to **claims 1, 6** also apply to **claim 7**.

50. With respect to **claim 8**, **Kinanen** suggests that the "field instability signal comprises a frequency distribution of field disturbances" [See col. 1 lines 37-62; col. 4 line 21 through col. 5 line 60 where a range 2-70hz; or 5-20hz based on the type of vibrational sensor is taught for the frequency distribution range]. The same reasons for rejection, and obviousness, that apply to **claim 1**also apply to **claim 8**.

51. With respect to **claim 10**, **Kinanen** suggests that the step of "generating an electromagnetic transfer function comprises performing an eddy current analysis" because the RF eddy currents in the gradient coils 24 and 26 are minimized by the RF shimming screens and shim coils 70 and 72; with the shimming controlled by shim coil control 74. [See col. 3 lines 61-65 and col. 4 line 64 through col. 5 line 4] It would have been obvious to one of ordinary skill in the art at the time that the invention was made that in order to minimize the eddy currents, that the location and intensity of the eddy currents produces must necessarily be known, therefore It would have been obvious to one of ordinary skill in the art at the time that the invention was made that the by teaching the minimization of the produced eddy currents, the use of shimming, (i.e. a

conventional means of reducing or minimizing eddy currents in the MRI / NMR art) and the teaching of counteracting changes in the magnetic field, which include fluctuations caused by induced eddy currents, that the **Kinanen** reference does perform an eddy current analysis, even though a direct teaching of a specific "eddy current analysis is lacked by the reference. The same reasons for rejection, and obviousness, that apply to **claims 1, 9** also apply to **claim 10**.

52. With respect to **claim 11**, **Kinanen** teaches and suggests the step of "performing a structural analysis of one or more MRI system components", because a vibrational analysis of the physical structural MRI components, (i.e. the pole pieces, magnets, gradient coils, rf coils, etc. is performed. [See abstract, figure 1, col. 2 line 26 through col. 5 line 60.] . The same reasons for rejection, and obviousness, that apply to **claims 1, 9** also apply to **claim 11**.

53. With respect to **claim 12**, **Kinanen** teaches and suggests the step of converting nodal displacements into rigid body motions'", because **Kinanen** teaches using the displacements of the "rigid body structures", (i.e. the amount of change or movement of the actual magnets, coils, and pole shoes/pieces) to an output waveform of vibration, and a calculated change in Bo that is processed by the vibrational analyzer. [See also the rejection reasons given in the rejection of **claim 7**] The same reasons for rejection, and obviousness, that apply to **claims 1, 6, 7, 9, 11** also apply to **claim 12**.

54. With respect to **claim 13**, **Kinanen** teaches and suggests the step of "multiplying said mechanical disturbance signal by said electromagnetic transfer function", because the activity waveform of the shim coil is inverted and scaled in comparison to the

vibration waveform, and the examiner broadly interprets the step of scaling to include the mathematical operations of addition, subtraction, multiplication, and division intrinsically. [See also the rejection reasons given in the rejection of **claim 7**] The same reasons for rejection, and obviousness, that apply to **claims 1, 6, 7, 9** also apply to **claim 13**.

55. With respect to **claim 14**, **Kinanen** suggests the step of "frequency sweeping said field instability signal to obtain a desired frequency operating range" because **Kinanen** specifically teaches that a 0.5 micrometer variation in aperture varies the Larmour frequency by 10 Hz., and the sensors used for the vibration detection and analysis are taught to provide accurate responses in the 2-70 hz., range, therefore a vibrational instability frequency sweep range of 2-70hz., is taught by the **Kinanen** reference. [See col. 4 line 21 through col. 5 line 60; and col. 1 lines 55-62] The same reasons for rejection, and obviousness, that apply to **claims 1, 9** also apply to **claim 14**.

56. With respect to **claim 15**, **Kinanen** teaches and suggests "modifying at least one MRI system feature to adjust one or more resulting frequency magnitudes" [See col. 4 line 21 through col. 5 line 60] The same reasons for rejection, and obviousness, that apply to **claims 1, 9** also apply to **claim 15**. .

57. With respect to **claim 16**, **Kinanen** teaches and suggests "modifying at least one MRI system feature to adjust a resulting frequency operating band to be approximately within a desired frequency operating range." [See col. 4 line 21 through col. 5 line 60; and col. 1 lines 55-62; where high-pass filters are used to eliminate frequencies below 2hz., in addition to the vibrational instability frequency sweep range of 2-70hz., taught

by the **Kinanen** reference; and where the ability to modify the phase, frequency, spatial location, of the detected frequencies is also taught.] The same reasons for rejection, and obviousness, that apply to **claims 1, 9** also apply to **claim 16**.

58. With respect to **claim 17**, **Kinanen** suggests balancing a resulting eddy current with a resulting amount of MRI system component movement in response to said field instability signal", because in **Kinanen** the activity waveform of the shim coil, is inverted and scaled (i.e. "balanced") in comparison to the vibration waveform, (i.e. "said field instability signal") [See col. 4 line 21 through col. 5 line 60; especially col. 4 line 63 through col. 5 line 4]. The same reasons for rejection, and obviousness, that apply to **claims 1, 9** also apply to **claim 17**.

59. With respect to **claim 19** this claim is just the combination of **method claims 9, 14, and 16** written in independent form therefore the same reasons for rejection, and obviousness, that apply to **claims 1, 9, 14, 16** also apply to **claim 19** and need not be reiterated.

60. **Claims 18, 20** are rejected under **35 U.S.C. 103(a)** as being unpatentable over **Kinanen** US patent **6,433,550 B1** issued August 13h 2002, filed February 13th 2001; in view of **Yamashita** US patent **6,556,012 B2** filed January 19th 2001.

61. With respect to **claim 18**, **Kinanen** lacks directly teaching the step of "modifying a cryostat or cryostat support material in response to said field instability signal". However, **Yamashita** teaches and shows a superconductive MRI cryostat for maintaining the extremely low temperature state of the superconductive coil. [See col. 4 lines 37-45] **Yamashita** also teaches compensating for any vibrations of the system.

[See col. 4 line 36 through col. 32 line 45, which explains 15 different embodiments for compensating for the vibrations produced by the MRI system]. The instability signal of **Yamashita** is also the signal(s) related to the vibrations experienced by the system. **Yamashita** teaches "modifying a cryostat or cryostat support material in response to" the vibrations produced by the system (i.e. "said field instability signal"), [See col. 5 line 2 through col. 6 line 46; col. 22 line 17 through col. 23 line 55; col. 20 lines 5-49]. It would have been obvious to one of ordinary skill in the art at the time that the invention was made to modify the teaching of **Kinanen** with the teaching of **Yamashita,** because the teachings of **Kinanen** apply to any MRI magnet system, while the teachings of **Yamashita,** apply specifically to a superconductive MRI system. The examiner also notes that because the cryostat is a rigid body that is also subject to motion that it also would have been obvious to one of ordinary skill in the art at the time that the invention was made, to modify the teachings of **Kinanen** to also analyze the vibrations generated within a functional superconductive MRI cryostat, because the **Kinanen** reference monitors, analyzes and compensates for all vibrational components in an operational MRI system. The same reasons for rejection, and obviousness, that apply to **claims 1, 9** also apply to **claim 18**.

62. With respect to **claim 20**, **Kinanen** suggests "balancing a resulting eddy current with a resulting amount of MRI system component movement in response to said field instability signal" for the same reasons as those given in the rejection of **claim 17.**

63. **Kinanen** lacks directly teaching the step of using that balance "to determine desired cryostat materials; and modifying a cryostat or cryostat support material to

reflect said desired cryostat materials." However, **Yamashita,** specifically determines and identifies "desired cryostat materials;"), [See col. 5 line 2 through col. 6 line 46; col. 22 line 17 through col. 23 line 55; col. 20 lines 5-49; Figures 1-6; 17-20; 24a-24d; 27-33 and 50-51]. **Yamashita,** also teaches "modifying a cryostat or cryostat support material to reflect said desired cryostat materials." [See col. 5 line 2 through col. 6 line 46; col. 22 line 17 through col. 23 line 55; col. 20 lines 5-49] The same reasons for rejection, and obviousness, that apply to **claims 1, 9, 14, 16, 17, 18, 19** and the motivation to combine that applies to **claim 18,** also apply to **claim 20** and need not be reiterated.

64. The **prior art made of record** and not relied upon is considered pertinent to applicant's disclosure.

A) **Zur** US patent 6,191,582 B1 issued February 12^{th} 2001, filed July 21^{st} 1999 which teaches a method for eddy current compensation, simulation, modeling, and improved stabilization in an NMR / MRI system. See the entire reference.

B) **Kinanen** US patent **6,433,550 B1** issued August 13h 2002, filed February 13^{th} 2001; which teaches an MRI magnet device with Vibration Compensation for all the MRI components.

C) **Jeker et al.,** US patent 5,744,959 which shows an NMR measurement apparatus with a pulse tube cooler.

D) **Havens et al.,** US patent application publication 2004/0051530 A1 which is the publication of applicant's originally filed instant application, which is noted for the purposes of a complete record. This reference is not available as prior art.

Conclusion

65. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Tiffany Fetzner whose telephone number is: (571) 272-2241. The examiner can normally be reached on Monday-Thursday from 7:00am to 4:30pm., and on alternate Friday's from 7:00am to 3:30pm.

66. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Diego Gutierrez, can be reached at (571) 272-2245. The **only official fax phone number** for the organization where this application or proceeding is assigned is **(703) 872-9306**.

Tiffany A. Fetzner

TAF
March 31, 2004

Diego Gutierrez
Supervisory Patent Examiner
Technology Center 2800

CHRISTOPHER W. FULTON
PRIMARY EXAMINER